(12) AUSTRALIAN PATENT ABSTRACT
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(54) CONVERTING SHAPE STRUCTURE TO PREVENT FROST AND FREEZE DAMAGE

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(57) Claim

1. A method for converting a shade structure covering an area into a structure protecting said covered area from frost and freezing for the season during which frost and freezing temperatures might be expected, said shade structure including a loosely woven fabric suspended above said covered area by cables supported by vertical posts, the steps comprising, applying to the said loosely woven fabric suspended above the covered area, prior to the start of such frost and freezing temperature season, a solution of a substantially water insolubilized, water soluble material and forming over not substantially more than 98% and not substantially less than 90% of the openings in such woven fabric, with said solution, a water solubility reversible, substantially water insulubilized closure, insolubilized to maintain said openings closed or substantially closed for the duration of said frost and freezing temperature season, said

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solution over said openings converting said woven fabric covering said area into a substantially air impervious, heat transfer resistant covering over said area, during periods in said season when frost and freezing temperatures occur, closing the sides around said area covered by said converted fabric covering to form an enclosure for plants and vegetation within said area and applying heat to said covered and enclosed area while the temperature in the area outside of said enclosure is below freezing to protect said plants and vegetation in said area from freezing damage, venting said enclosure area when the temperature in the area outside of said enclosure is substantially above freezing by opening the sides around said area to vent said area and prevent said plants and vegetation in said area from being overheated and re-water solubilizing said water insolubilized, water soluble material and removing said material from said woven fabric openings at the end of said frost and freezing season to reopen said openings in said woven fabric and restore said cover protecting said area to a loosely woven fabric shade structure.

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COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE :

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Application Number : 17253/83
Lodged :

Complete Specification Lodged :
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Related Art :

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Complete Specification for the invention entitled :

"METHOD FOR CONVERTING A SHADE STRUCTURE INTO A PROTECTIVE ENCLOSURE TO PROTECT VEGETATION BEING GROWN THEREUNDER FROM FROST AND FREEZE DAMAGE"

The following statement is a full description of this invention, including the best method of performing it known to me/us:

This application is a continuation-in-part of U.S. application Serial No. 24,405, filed March 27, 1979, which, in turn, is a continuation-in-part of U.S. application Serial No. 913,503, filed June 7, 1978, now U.S. patent 4,145,855, dated March 27, 1979 and relates to the protection of cultivated plant life from frost and freezing and, more particularly, to the protection of agricultural crops and decorative flowers and ferns from frost and freeze damage.

The southermost temperate regions of the United States, such as Florida, Southern California and Texas, are used extensively for growing nutritious and ornamental plants and flowers. Thus, lettuce, tomatoes, celery, flowers, decorative ferns and other nutritious and ornamental plants are grown in such regions for, substantially, twelve months of the year. Because of the sun's intensity or the preference of some plants, such as decorative ferns, for shade, large areas in which nutritious or ornamental plants or flowers are grown are covered by shade structures. Typically, such shade structures are made up of spaced vertical posts on which are supported wires or cables stretched horizontally and parallel to the ground surface to be shaded across which are stretched a loose woven fabric, such as burlap. Such shade structures have been known at least as early as Hayes U.S. patent 727,541, dated May 5, 1903. The loose woven fabric breaks up and diffuses the sunlight while, at the same time, allowing moisture, such as from rain, to pass through the fabric cover. Such structures may be built to withstand storms and heavy winds and may be covered with a loosely woven cloth of plastic material such as polypropylene plastic shade cloth as, for example, in

applicant's U.S. patent 4,068,404, dated January 17, 1978.

One of the hazards of growing nutritious and ornamental plants and flowers in the souther, temperate regions of the United States is the occurrence, from time-to-time, of frost and freezing temperatures. While prevailing temperatures, even in the mid-winter months, are well above frost and freezing, sub-normal temperature causing frost and freezing infrequently occur. While such occurrences are usually for short intervals and at a frequency which does not require shortening of the growing season, nevertheless when such sub-normal temperatures do occur, the resulting damage can be substantial. Not only can the crop then growing be damaged but in many instances such as, for example, decorative fern, the plant itself might be destroyed. Such losses can take months, even years, to replace.

Many arrangements have, heretofore, been suggested and employed for protecting crops from frost and freezing temperature. One such arrangement has consisted in the placing of smudge pots at spaced intervals in the field in which the crop to be protected is located and burning in such pots a smoke producing fuel. The smoky pall or cloud of smudge so produced hangs, like a cloud, over the field and protects the field from the frost and freezing temperature. Such arrangement is of little value where the cold temperature is accompanied by wind. Furthermore, the use of smudge pots tends to pollute the surrounding environment, requires round-the-clock attendants to maintain and fuel the smudge pots, consumes fuel and is wasteful.

Another arrangement, heretofore frequently employed

when frost or freezing temperatures occur, has been to spray the crops with a water mist which, in the freezing temperature, freezes and forms ice on the crop being protected. The spraying of the water must be continued while the temperature remains below freezing. The ice formed on the crop continues to build up. This prevents the crop temperature from falling below freezing temperature and from freezing. The weight of the ice can, and often does, cause damage to the newer, tendered crop growth and the cost of pumping and spraying water over an extended period of freezing temperature can be high. More importantly, however, because in most areas such water is pumped from wells, substantial lowering of the water table and forming of sinkholes can occur. Furthermore, wells may run dry and the water supply may become salty. Wells that are salty are of little value.

U.S. patent application Serial No. 913,503, filed June 7, 1978, shows and describes a system wherein an enclosed space, such as a house, carport, porch and the like, having openings covered with, for example, wire screens, may be protected from extremely low temperatures by applying a sealant of a water-removable material to the wire screen openings. Such sealant forms a closure over the screen openings and retains heat in the enclosure. Once the temperature rises above freezing and can be expected to remain above the freezing temperature, the sealant material can be removed by washing the wire screens, removing the sealant from the screen openings.

It has been discovered, in the instant invention, that the system for protecting enclosed spaces from extremely

low temperatures, as shown and described in my co-pending application can be modified and combined with the shade structure, as for example, shown and described in the aforementioned '541 and '404 patents, to protect nutritious and ornamental plants and flowers from frost and freeze damage.

In the instant invention, the coating material of my co-pending application, or a similar water soluble material, is applied to the underside of the woven fabric or shade cloth of the shade structure to form a bridge or cover over the openings in the fabric or cloth. By an additive to the coating material, added to the material or applied after coating, the coating material is substantially insolubilized. Thus, the loosely woven fabric or cloth is converted into a reinforced, heat transfer resistant, cover over the plant area. By then closing the sides of the coverted shaded structure with tarps, plastic sheets, or shade cloth similarly coated, the converted shade structure becomes an enclosure for the plants to be protected. The enclosure and the plants therein may then be maintained at a temperature at which such plants will not be damaged. Thus, while frost and freezing temperature prevail, the enclosed plants are protected.

The coating material, insolubilized by addition to the material or after coating, is applied to the underside of the woven fabric so that most, but not all, of the woven fabric or shade cloth openings are closed. This can be accomplished by applying the material so as to leave openings randomly distributed over the coated area or by applying the material so as to coat the openings continuously and leaving

a spacing between coated strips. When coated, not substantially less than 90% and not substantially more than 98% of the woven fabric or shade cloth should be coated. The open or uncoated areas allow water, such as from rainfall, to pass through the coated fabric or cloth. This is important because, otherwise, the weight of the water might damage or collapse the structure.

The water insolubilizable coating is applied to the underside of the shade structure fabric or cloth before the cold weather period arrives and is removed after the cold weather period has passed. Thus, the underside of the shade structure fabric or cloth may be sprayed with the coating material a month or more before freezing weather is expected and may be removed a month or so after the cold weather period has passed. By utilizing a normally water soluble material and adding to that material, either before coating or after the coating has been applied, an additive which makes the coating water insoluble or substantially water insoluble, the coating can be applied before the expected cold weather period and be allowed to remain in place until the cold weather period passes. Rain which might fall during such period will pass through the holes left in the coating or between coated areas for that purpose.

The water insolubility of the coating material might be so adjusted so that, after the cold weather period has passed, the coating material will solubilize and be removed by the rains which, in many areas, prevail after the cold season or the insolubilizing additive added to the coating material or applied after coating might be selected so that the coating material might be resolubilized or hydrolyzed.

Methyl cellulose to which glyoxal is added before coating or to which a mild tannic acid solution is applied after coating have been found to provide satisfactory water insolubilized coatings which can readily be resolubilized or hydrolyzed and washed or leached from the fabric or cloth after the cold period has passed with a mild bicarbonate of soda solution. The methyl cellulose, glyoxal, tannic acid and bicarbonate of soda are all non-toxic material and, in the quantities employed, are not harmful to plant life. Hence, these materials, as will be described in more detail, have been found most suited for purposes of the instant invention.

The invention of the instant application will be better understood from the following description of a preferred embodiment taken with the appended drawings in which:

Figure 1 is a perspective view, partly in section, showing a shade structure to which the invention is to be applied;

Figure 2 is an enlarged view, partially in section, of a section from the shade cloth of the structure of Figure 1;

Figure 3 is an enlarged view, similar to Figure 2 but showing a section to which the instant invention has been applied;

Figure 4 is a sectional view taken at 4-4, Figure 2;

Figure 5 is a sectional view taken at 5-5, Figure 3; and

Figure 6 is a section view similar to Figure 5 but taken at 6-6, Figure 3.

Referring to the drawings, the shade structure to

which the invention of the instant application is shown applied is made up of a plurality of posts 2, set into the ground 4 at suitable spacings and extending substantially vertical upward from the ground. Such posts 2 may be of wood, concrete, or metal and, preferably, are of wood, for example, 3 in. x 3 in. or 4 in. x 4 in. wooden posts 10 feet in length, set into the ground about 18 inches with their tops about 8 1/2 feet from the ground. Preferably, the posts are uniformly spaced and are set into the ground so that the tops of the posts are substantially planar. This uniform spacing and arrangement of the post tops facilitates the cultivation of the plants under the structure, provides a substantial planar shade cover and will facilitate the application and removal of the water-removable coating, as will be later more apparent.

Vertical posts 2 may be suitably uniformly spaced on center of about 10 to 12 feet such as in the uniform spacing arrangement in the '541 patent and in Figure 1 of the appended drawings or may be spaced at 10 to 12 feet, on center, around the periphery of the area and capped with a horizontal strip, with the center posts in the area more widely spaced, such as in the shade structure arrangement in the '404 patent.

Referring still to the drawings, parallel longitudinal extending cables 6 and parallel transversely extending cables 8 extend across the top of the shade structure and across the tops of posts 2, cables 6 and 8 are staked to ground 4 at their opposite ends, such as by stakes, not shown. Cables 6 and 8 may be interwoven with each other so that, when stretched across the tops of posts 2 and staked

at the ends, such cables form a planar mat across the tops of the posts.

Cover 10 which may be of one piece but, preferably is of strips 4 ft., 6 ft., 8 ft., or the like, in width, overlapped along the edges and sewn or joined together, such as with pins or nails through aligned openings in the cloth edges. The strips may be individually applied, stretched and then joined at the edges or may first be joined, such as by sewing, and then applied and stretched. Cover 10 may be of any open weave cloth but, preferably, is of synthetic, sun and weather resistant fiber , such as polypropylene plastic shade cloth.

Open weave cover cloth 10, when in position over the field, provides a shade structure which, depending upon the weave or density of the shade cloth or fabric, blocks or filters out a portion of the sunlight. In cooler climates where the sun is not so bright or where plant or foliage tolerance to sun rays is higher, a 47% shade cloth or fabric might be employed while, in warmer climates or where plant or foliage tolerances are not so high a denser cloth or fabric, for example 73%, might be employed. Thus, as shown in enlarged views in Figures 2 and 4, the open spacing between woven filaments 12, 14 not only allow filtered sunlight to pass through the shade structure but, in addition, when it rains, allows water to pass through.

In the present invention, as already noted, the shade structure is converted into a cold weather protected area by applying a coating of a substantially water insolubilizable, water soluble material to the undersurface of the shade fabric or cloth so that not substantially less than 90% and

not substantially more than 98% of the woven cloth area is coated or sealed by the material. The insolubility of the coating material is reversible, that is, the shade fabric or cloth coating can be sprayed with a material which hydrolyzes or returns the coating to a water soluble condition. The resolubilized coating might then be rinsed or leached from the shade fabric or cloth.

There are many water soluble materials which, when mixed with water, can be applied to a shade fabric or cloth and will bridge over and cover the fabric or cloth openings, can be water insolubilized and can later be neutralized or hydrolyzed. Methyl cellulose and etherified derivatives of polyols, such as, dextrin, starch and poly (vinyl alcohol) and other such materials, alone or in combination with plasticizers, thickening agents, stabilizers, and the like and capable of forming a water insolubilizable film bridging over and covering the openings might be employed. Methyl cellulose, such as METHOCEL K4MS, sold by Dow Chemical Company, Midland, and Hydroxethyl Cellulose sold by Hercules, Inc., Wilmington, Delaware, have been found particularly suited for purposes of the invention. A solution made up of about 4 ounces of Dow Chemical methyl cellulose per gallon of water has been found to be suitable.

The solution may be applied to the underside of the shade fabric or cloth by brushing, wiping, rolling or by spraying. Spray application, at an angle of about 40^{o} to the plane of the shade cloth, has been found to be particularly satisfactory. After the cloth has been sprayed or coated from the underside with the 4 ounce per gallon

methyl cellulose solution, a solution of tannic acid in water is applied to the methyl cellulose coating. This might be done after the methyl cellulose coating has dried but, preferably is applied while the initial methyl cellulose coating is still wet. Solution of 1 1/2% to 3% by weight of tannic acid in water have been found suitable for sufficiently insolubilizing the methyl cellulose coating. Other materials which can be formed into an aqueous spray and applied to the methyl cellulose to combine and make the methyl cellulose substantially insoluble might also be employed.

Rather than applying the insolubilizing agent, such as the tannic acid, to the methyl cellulose after coating, it is preferred in the practice of the instant invention to add an insolubilizing agent to the methyl cellulose solution before the solution is applied to the underside of the shade structure. There are a number of agents which, like tannic acid, are known to cross-link with methyl cellulose to form insoluble or substantially insoluble coatings but, unlike tannic acid, cross-link as the solution dries or the water evaporates from the mixture. Such agents include glyoxal, vinyl acetate-maleic anhydride copolymer, dimethylolurea and citric acid. Such agent is added to the methyl cellulose solution in an amount sufficient to cross-link so that the methyl cellulose coating is water insoluble or substantially water insoluble when applied to the shade fabric or cloth and dried.

The methyl cellulose water insolubilized coating is applied to the underside of the shade fabric or cloth and forms a thin film over the openings much like the water film

on a window or door screen after a rain. Randomly, as best shown in Figure 3 of the drawings one or more openings, usually in a group, will remain open while the surrounding openings are closed. Thus, as shown at 5-5, Figure 3 and in Figure 5, film 16 forms around filaments 12, 14 and discontinuously in the spacings between the filaments. The continuous portion of the film is best shown at 6-6, Figures 3 and in Figure 6. The coating may also be applied, as already noted, as a continuous film bridging all of the fabric or shade cloth openings. However, when so applied as a continuous film, uncoated areas making up not substantially less than 2% and not substantially more than 10% of the total shade structure area and well distributed throughout the area should be left so that rain water might flow therethrough.

The film is applied to the shade cloth before the cold weather period commences and is applied so as to remain on the shade fabric or cloth during such cold weather period. Ideally, the film is applied so as to remain in place or substantially in place for the duration of the cold period but to then break down or decompose so that the film or coating can be leached or washed from the cover fabric or cloth by rains or with water. Such breaking down or decomposing of the film or coating may not occur before warm weather arrives. While the temperature within the structure might be relieved by removing the side covers and providing holes or vents in the cover fabric or cloth over roadways, conventially found in such structures for working or harvesting the crop, the heat relief so provided might be insufficient for the workers and the crops therein.

This problem of possible overheating is overcome in

the instant invention by the utilization of water insolubilizing agents in the methyl cellulose which are reversible. Thus, in the system of the instant invention, the insolubilized methyl cellulose, whether after coated, such as with tannic acid, or insolubilized with glyoxal, vinyl acetate-maleic anhydride copolymer, dimethylolurea or citric acid addition, may be sprayed with an aqueous bicarbonate of soda solution which neutralizes the insolubilizing agent, and renders the coating soluble. Thus, the coating might be washed off or leached from the shade cover fabric or cloth with the bicarbonate of soda solution or might first be treated with the solution and then washed or leached with water. The bicarbonate of soda and residue washed or leached from the cover fabric or cloth is not harmful to vegetation or to a person who might be under the shade structure and wetted therewith. Other reversing or neutralizing agents which are not harmful to the shade cloth material, the vegetation covered thereby or to personnel involved therewith, and which are effective to neutralize the insolubilizing agent and hydrolyze the film might also be employed.

The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, but, it is recognized that various modifications are possible within the scope of the invention claimed.

The claims defining the invention are as follows:

1. A method for converting a shade structure covering an area into a structure protecting said covered area from frost and freezing for the season during which frost and freezing temperatures might be expected, said shade structure including a loosely woven fabric suspended above said covered area by cables supported by vertical posts, the steps comprising, applying to the said loosely woven fabric suspended above the covered area, prior to the start of such frost and freezing temperature season, a solution of a substantially water insolubilized, water soluble material and forming over not substantially more than 98% and not substantially less than 90% of the openings in such woven fabric, with said solution, a water solubility reversible, substantially water insulubilized closure, insolubilized to maintain said openings closed or substantially closed for the duration of said frost and freezing temperature season, said solution over said openings converting said woven fabric covering said area into a substantially air impervious, heat transfer resistant covering over said area, during periods in said season when frost and freezing temperatures occur, closing the sides around said area covered by said converted fabric covering to form an enclosure for plants and vegetation within said area and applying heat to said covered and enclosed area while the temperature in the area outside of said enclosure is below freezing to protect said plants and vegetation in said area from freezing damage, venting said enclosure area when the temperature in the area outside of said enclosure is substantially above freezing by opening the sides around said area to vent said area and prevent said

plants and vegetation in said area from being overheated and re-water solubilizing said water insolubilized, water soluble material and removing said material from said woven fabric openings at the end of said frost and freezing season to reopen said openings in said woven fabric and restore said cover protecting said area to a loosely woven fabric shade structure.

2. A method, as recited in claim 1, in which said material is applied to the underside of said loosely woven fabric cover.

3. A method, as recited in claim 2, in which said water soluble material is selected from the group consisting of methyl cellulose and etherified derivatives of polyols, such as, dextrin, starch and poly (vinyl alcohol).

4. A method, as recited in claim 3, in which said water soluble material is insolubilized with a material selected from the group consisting of tannic acid, glyoxol, vinyl acetate-maleic anhydride copolymer, dimethylolurea and citric acid.

5. A method, as recited in claim 1, in which said water soluble material is insolubilized by spraying said water soluble material applied to said fabric covering with an aqueous solution of tannic acid.

6. A method, as recited in claim 5, in which said tannic acid solution is sprayed on said water soluble material on said fabric covering after said water soluble material has dried.

7. A method, as recited in claim 5, in which said tannic acid solution is sprayed on said water soluble material on said fabric covering before said water soluble

material has dried.

8. A method, as recited in claim 1, in which said water insolubilized water soluble material in the opening in said fabric is resolubilized by spraying said converted fabric with a neutralizer to rehydrolyze said water soluble material.

9. A method, as recited in claim 8, in which said neutralizer is an aqueous solution of bicarbonate of soda.

10. A method for converting a shade structure covering an area into a structure protecting said covered area from frost and freezing for the season during which frost and freezing temperatures might be expected, said shade structure including a loosely woven fabric suspended above said covered area by cables supported by vertical posts, the steps comprising, applying to the underside of said loosely woven fabric suspended above the covered area, prior to the start of such frost and freezing temperature season, an aqueous solution of a substantially water insolubilized, methyl cellulose material and forming over not substantially more than 98% and not substantially less than 90% of the openings in such woven fabric, with said solution, a water solubility reversible, substantially water insolubilized closure, insolubilized to maintain said openings closed or substantially closed for the duration of said frost and freezing temperature season, said solution over said openings converting said woven fabric covering said area into a substantially air impervious, heat transfer resistant covering over said area, during periods in said season when frost and freezing temperatures occur, closing the sides around said area covered by said converted fabric covering to

form an enclosure for plants and vegetation within said area and applying heat to said covered and enclosed area while the temperature in the area outside of said enclosure is below freezing to protect said plants and vegetation in said area from freezing damage, venting said enclosure area when the temperature in the area outside of said enclosure is substantially above freezing by opening the sides around said area to vent said area and prevent said plants and vegetation in said area from being overheated and re-water solubilizing said water insolubilized, methyl cellulose material and removing said material from said woven fabric openings at the end of said frost and freezing season to reopen said openings in said woven fabric and restore said cover protecting said area to a loosely woven fabric shade structure.

11. A method, as recited in claim 10, in which said methyl cellulose is applied to the underside of said shade cloth as an aqueous solution and is then insolubilized by spraying said methyl cellulose on said shade cloth with an aqueous tannic acid solution.

12. A method, as recited in claim 11, in which said methyl cellulose on said shade cloth is sprayed with said aqueous tannic acid solution before said methyl cellulose has dried on said shade cloth.

13. A method, as recited in claim 11, in which said methyl cellulose on said shade cloth is sprayed with said aqueous tannic acid solution after said methyl cellulose has dried on said shade cloth.

14. A method, as recited in claim 11, in which said inbsolubilized methyl cellulose on said shade cloth is resolubilized by spraying said shade cloth with an aqueous

solution of bicarbonate of soda.

15. A method, as recited in claim 10, in which said methyl cellulose applied to the openings in said shade cloth is insolubilized by adding glyoxol to said aqueous methyl cellulose solution before said solution is applied to the underside of said shade cloth and by drying said methyl cellulose-glyoxol on said shade cloth in said openings.

16. A method, as recited in claim 15, in which said insolubilized methyl cellulose on said shade cloth is resolubilized by spraying said shade cloth with an aqueous solution of bicarbonate of soda.

DATED this TWENTY SECOND day of JULY, 1983

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FIG.1

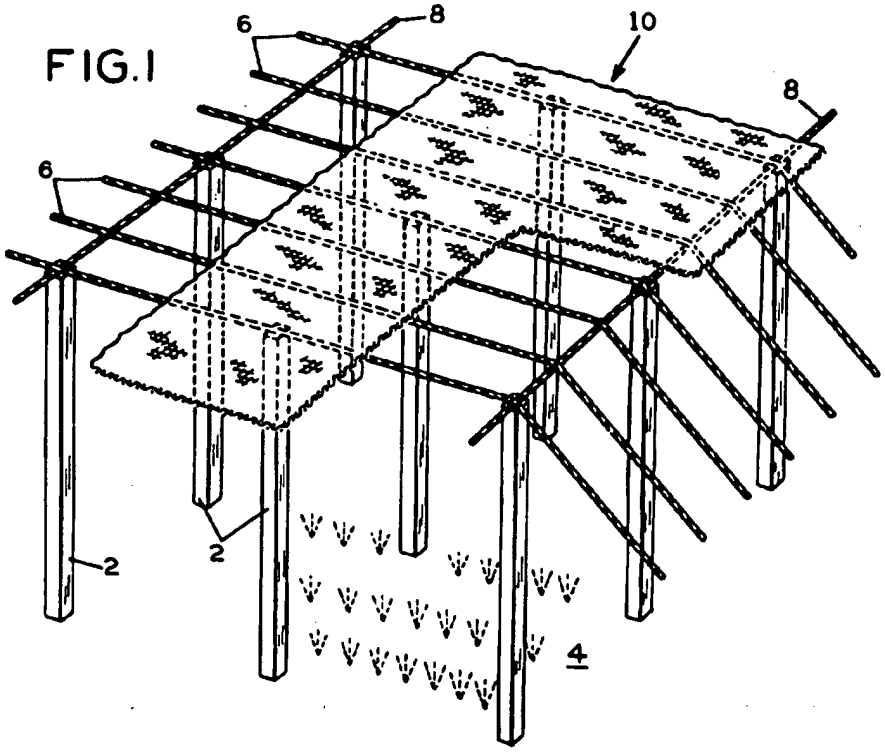

FIG.2

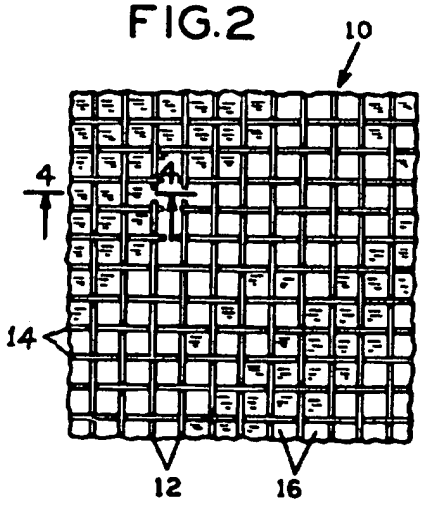

FIG.3

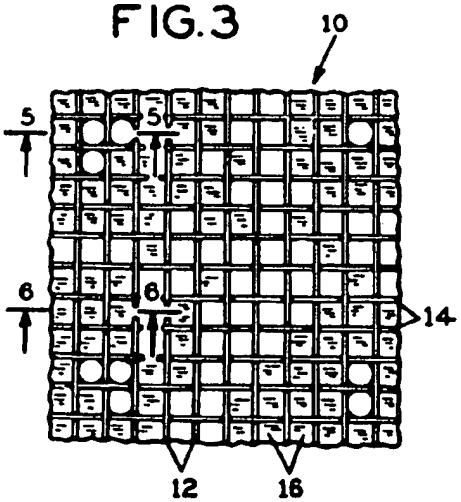

FIG. 4

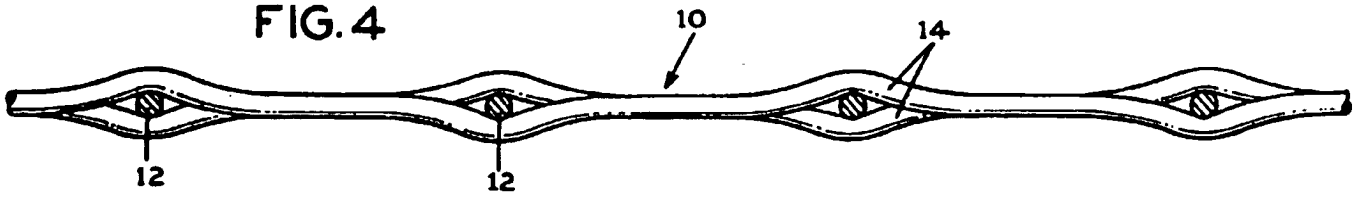

FIG. 5

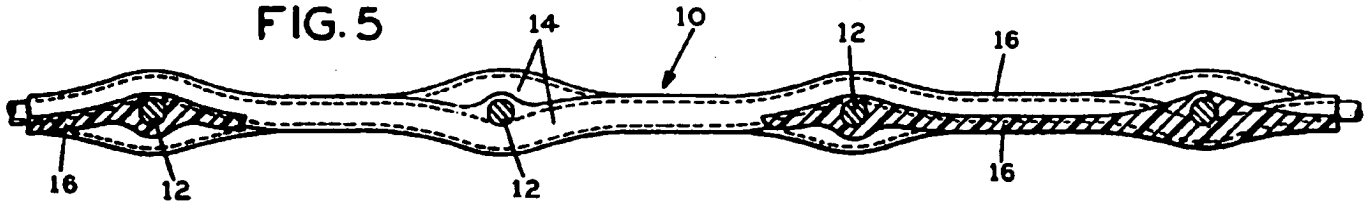

FIG. 6